

Maximum Effect for Minimum Means: The Aesthetics of Efficiency

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Figure 1 *Aware Puzzle Switch* (2007).
Designed by Looove Broms and Karin
Ehrnberger. The Aware Project. The Interactive
Institute, Sweden. Photo by the designers.

Figure 2 *Social Cups II* (2005).
Designed by Kristina Niedderer. The Argen-
tium Project. Made with support from The
Arts Council England. Photo by the designer.

Figure 3 *Doing Time* (2013).
Designed by Sara Ferrari. Made in collabora-
tion with long-sentenced inmates of the
Rebibbia prison, Italy. Photo by the designer.

Figure 4 *Dopper* (2010).
Designed by Rinke van Remortel based on an
idea by Merijn Everaarts, founder of Dopper,
The Netherlands. Photo by Odette da Silva.

Introduction

The aesthetic judgment of an artifact is typically interpreted as an evaluation of the artifact's sensory properties. In this sense, the light switch shown in Figure 1 can be aesthetically appreciated for its color contrast; the drinking cups in Figure 2 for their smooth texture; the wall clock in Figure 3 for its soft surface; and the water bottle in Figure 4 for its visual unity. However, these products can also be appreciated, and still aesthetically, because of an understanding of the relationship between the product itself and its purpose (or function, or effect). Existing design theory does not provide the concepts required for describing this aspect of aesthetic appreciation and so cannot fully explain what people mean when they say a product is beautiful. In this paper, we develop an understanding of the role of product effects in design aesthetics.

- 1 See Jane Forsey, *The Aesthetics of Design* (New York: Oxford University Press, 2013); Glenn Parsons and Allen Carlson, *Functional Beauty* (Oxford: Oxford University Press, 2008); and Yuriko Saito, *Everyday Aesthetics* (Oxford: Oxford University Press, 2007).
- 2 For a historical overview, see Władysław Tatarkiewicz, *A History of Six Ideas: an Essay in Aesthetics* (The Hague: Martinus Nijhoff, 1980), 121–52. See also Paul Guyer, “Beauty and Utility in Eighteenth-Century Aesthetics,” *Eighteenth-Century Studies* 35, no. 3 (2002): 439–53. Kant’s notion of dependent beauty, which involves a perception of purposefulness, is examined by Robert Wicks in “Dependent Beauty as the Appreciation of Teleological Style,” *The Journal of Aesthetics and Art Criticism* 55, no. 4 (1997): 387–400; and by Philip Mallaband in “Understanding Kant’s Distinction Between Free and Dependent Beauty,” *The Philosophical Quarterly* 52, no. 206 (2002): 66–81.
- 3 Products can be appreciated for having been designed as means to achieve certain effects—whether these effects are realized in practice or just intended. In many circumstances, actual effects might be taken as an indication of intended effects, or intended effects might be all that is known if the actual effects are not observable (e.g., because of time delays). As such, we do not distinguish here between actual and intended effects. In any case, the aesthetic appreciation of products, as we discuss it, depends on products’ effects as *perceived* by people in any possible way, including first-hand experience and knowledge of designers’ intentions. For the four main product examples in this paper, the effects described were intended by the designers. (See the sources cited in notes 4 through 7). In the absence of direct statements by the designers, people might infer the designers’ intended effects directly from the products. See Nathan Crilly, “The Design Stance in User–System Interaction,” *Design Issues* 27, no. 4 (2011): 16–29; and Nathan Crilly, “Do Users Know What Designers Are Up to? Product Experience and the Inference of Persuasive Intentions,” *International Journal of Design* 5, no. 3 (2011): 1–15.

Contemporary literature in philosophical aesthetics acknowledges that the aesthetic appreciation of an artifact can be influenced by knowledge of the artifact’s purpose.¹ This idea follows a strand of thought that can be traced back to the Enlightenment and further back to Antiquity—a strand that relates beauty to an artifact’s aptitude to perform a task.² From this perspective, the products presented in Figures 1 through 4 can be aesthetically appreciated not just for their sensory properties, but also for the effects that they are intended to achieve through these properties.³ The light switch encourages energy conservation by showing a disrupted visual pattern when the light is on, thus stimulating people’s innate need for order, which makes them rearrange the pattern and so turn the light off.⁴ The drinking cups trigger human interaction because they are unstable unless rearranged all together, thus requiring people to collaborate with each other if they are to put the cups down without spillage.⁵ The wall clock encourages prison inmates to express themselves creatively by providing them with “a skin to tattoo” (i.e., leather to draw on); in addition, it stimulates those who are not in jail to better appreciate time by prompting reflection on life behind bars.⁶ The water bottle reduces plastic waste by being robust and cleanable, thus permitting reuse and encouraging people to avoid buying bottled drinks; it also promotes drinking of tap water by having a large opening and providing an in-built cup—features that facilitate refilling.⁷ As these descriptions suggest, all these products can be perceived to be beautiful in light of their effects.

Although an artifact can be appreciated for its effect, a difference does exist between appreciating an artifact because it achieves a given effect and appreciating it because of *the way* it achieves that effect. A candle can be appreciated because it lights up a room, regardless of whether it is simply shaped or intricately carved—regardless of its particular sensory properties. But it can also be appreciated because of the way it lights up the room, which cannot be dissociated from the way it is shaped, from the qualities that it presents to the senses. As Faraday observed, a candle can only light up a room in a steady manner if it is simply shaped.⁸ He saw great beauty in an ordinary candle for this reason, arguing that beauty does not necessarily lie in the best looking things, but in the “best acting” ones. The appreciation of the way in which an artifact achieves an effect necessarily involves a sensory appreciation of the artifact. This sensory basis for the appreciation is what makes it *aesthetic*.⁹

Many design principles explain aesthetic appreciation in the traditional sense,¹⁰ but no such set of principles has been offered to account for the judgment of the way a product achieves a certain effect. In searching for a basis from which such a set might be developed, we first turn to literature in design aesthetics,

- 4 Looove Broms, "Sustainable Interactions: Studies in the Design of Energy Awareness Artefacts" (Licentiate thesis, Linköping University, 2011).
- 5 Kristina Niedderer, "Designing Mindful Interaction: The Category of Performative Object," *Design Issues* 23, no. 1 (Winter 2007): 3–17.
- 6 Sara Ferrari, personal communication (December 16, 2013).
- 7 "Dopper: The Bottle is the Message," <http://nl.dopper.com/en/> (accessed July 16, 2014).
- 8 Michael Faraday, *The Chemical History of a Candle* (1861; repr. Oxford: Oxford University Press, 2011), 1–16.
- 9 Forsey, *The Aesthetics of Design*, Parsons and Carlson, *Functional Beauty*, and Saito, *Everyday Aesthetics*, stress that the way in which an artifact performs a function can be aesthetically appreciated. Taking a knife as an example, Saito explains: "The appreciation here is not simply directed toward the fact that the knife functions well; it rather concerns *the way in which* all its sensuous aspects converge and work together to facilitate the ease of use." See Saito, *Everyday Aesthetics*, 27. We distinguish the attitude underlying aesthetic appreciation from an instrumental one. An instrumental attitude leads people to perceive artifacts "in terms of their usefulness for promoting or hindering [their] purposes," whereas an aesthetic one allows for a "disinterested" contemplation. See Jerome Stolnitz, "The Aesthetic Attitude," in *Introductory Readings to Aesthetics*, ed. John Hospers (New York: The Free Press, 1969), 18–19. See also Alan Goldman, "The Aesthetic," in *The Routledge Companion to Aesthetics*, ed. Berys Gaut and Dominic McIver Lopes (London: Routledge, 2001), 181–92. With an instrumental attitude, people appreciate a product for achieving an effect that is in line with their interests, as discussed by Jonathan Gutman in "A Means-End Chain Model Based on Consumer Categorization Processes," *The Journal of Marketing* 46, no. 2 (1982): 60–72. In contrast, with an aesthetic attitude, people appreciate a product independently of their own interests, for how it achieves a given effect.

which points at the principle of *maximum effect for minimum means* (MEMM).¹¹ This principle is also referred to as "economy," "efficiency," and "Occam's razor" in product design and design methodology handbooks.¹² These sources, however, do not provide a deep examination of the principle; they only indicate that a product is aesthetically appreciated when it is perceived to be an efficient solution to a given problem. Meanwhile, a body of related literature suggests that MEMM governs people's aesthetic appreciation of a wide range of things, including line drawings, literary metaphors, logical arguments, chess moves, architectural works, tennis serves, science experiments, and mathematical demonstrations. Just like products, all these things can be understood as artifacts because they are made with a certain effect in mind or are intended to perform in a certain way.¹³

Artifacts are aesthetically praised in MEMM terms when they achieve a lot with a little—"the most" with "the least." Drawings are found to be aesthetically pleasing when a limited number of lines allows for many non-contradictory interpretations.¹⁴ Metaphors are aesthetically pleasing because they economically relate two apparently dissimilar concepts.¹⁵ Arguments are thought to be elegant when they provide a comprehensive explanation briefly and without any redundancy.¹⁶ Likewise, a checkmate is considered to be beautiful when it is achieved without capturing a piece.¹⁷ Beauty is perceived in a simple building that fulfills an important social function or many such functions,¹⁸ just as it is perceived in the economical movement by which a tennis player serves a clean ace.¹⁹ Eratosthenes's measurement of the circumference of the Earth by means of a tiny shadow is found to be aesthetically pleasing,²⁰ as is Euclid's demonstration of the infinitude of prime numbers by means of a short mathematical proof.²¹ All these examples suggest that MEMM has a universal capacity to explain the aesthetic appeal of artifacts.

Any artifact can be understood as a designed product. Whether a mathematical proof or a light switch, an artifact is intentionally designed as a *means* to achieve a certain *effect* (e.g., demonstrating the infinitude of primes or promoting energy conservation). The aesthetic appreciation of an artifact can therefore involve the appreciation of a means–effect relationship. MEMM indicates that this relationship is aesthetically pleasing when it is perceived to be "minimum–maximum," where minimum is the magnitude of the means and maximum is the magnitude of the effect. These magnitudes can be interpreted in different ways. For instance, minimum can be interpreted as "small" (e.g., Eratosthenes's shadow) or "few" (e.g., Euclid's lines of math), whereas maximum can be interpreted as "big" (e.g., the size of the Earth) or "many" (e.g., the prime numbers). "Small" or "few" and "big" or "many" can only be considered "minimum"

- 10 Symmetry, golden ratio, and the rule of thirds are only some of these principles, as noted by William Lidwell, Kritina Holden, and Jill Butler in *Universal Principles of Design: 125 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach Through Design* (Beverly, MA: Rockport, 2010), 172–73.
- 11 See Paul Hekkert, “Design Aesthetics: Principles of Pleasure in Design,” *Psychology Science* 48, no. 2 (2006): 157–72; and Paul Hekkert and Helmut Leder, “Product Aesthetics,” in *Product Experience*, ed. Hendrik N. J. Schifferstein and Paul Hekkert (Amsterdam: Elsevier, 2008), 259–85.
- 12 See, respectively, Paul Zelanski and Mary Pat Fisher, *Design: Principles and Problems* (New York: CBS College Publishing, 1984), 31–32; Maggie Macnab, *Design by Nature: Using Universal Forms and Principles in Design* (Berkeley, CA: New Riders, 2012), 35–66; and Lidwell et al., *Universal Principles of Design*, 172–73.
- 13 This broad notion of artifact is based on the definitions offered by Risto Hilpinen and Randall R. Dipert. Hilpinen describes artifacts as “physical objects which have been manufactured for a certain purpose or intentionally modified for a certain purpose.” See Risto Hilpinen, “Artifacts and Works of Art,” *Theoria* 58 (1992): 58. Dipert further argues that artifacts can include “certain types of intentional events (e.g., utterances and performances).” See Randall R. Dipert, *Artifacts, Art Works, and Agency* (Philadelphia: Temple University Press, 1993), 11.
- 14 Frans Boselie and Emanuel Leeuwenberg, “Birkhoff Revisited: Beauty as a Function of Effect and Means,” *The American Journal of Psychology* 98, no. 1 (1985): 1–39.
- 15 V. S. Ramachandran and William Hirstein, “The Science of Art: a Neurological Theory of Aesthetic Experience,” *Journal of Consciousness Studies* 6, nos. 6–7 (1999): 15–51. In addition, just like certain drawings, metaphors allow for a number of non-exclusory interpretations. As a result, they are considered to be aesthetically pleasing. See Abraham Kaplan and Ernst Kris, “Esthetic Ambiguity,” *Philosophy and Phenomenological Research* 8, no. 3 (1948): 415–35.

(the least) and “maximum” (the most) in relation to other options. Thus, when we are not making relative claims, we use the terms “minimal” and “maximal” to be grammatically correct.

We must acknowledge that a means–effect relationship can be aesthetically appreciated for reasons other than MEMM. Some sources indicate that artifacts are also appreciated for their *unexpectedness* and *inevitability*. These qualities have been used to describe the beauty of mathematical demonstrations, buildings, dance moves, poems, science experiments and theories, as well as musical compositions.²² But in contrast to unexpectedness and inevitability, MEMM provides the grounds to examine the aesthetic judgment of an artifact as that of a means–effect relationship—a relationship that can be aesthetically appreciated for being efficient (i.e., minimum–maximum), but also unexpected or inevitable, among other possible qualities. Hence, MEMM not only accounts for the aesthetic appeal of many different artifacts, but also offers a basis for identifying the different factors that explain such appeal.

Having introduced the concept of MEMM and discussed its wide applicability, we proceed to explore the principle in the context of design aesthetics. We first explain how the means–effect relationship can be established between a product and its effect or purpose, and how the product and the effect can be perceived to be minimal and maximal. Next, we explain how the appreciation of the relationship between a given product or means and a given effect depends on a set of assumed alternatives for both the means and the effect. Finally, we provide some directions for future research into design aesthetics.

The Basics of the MEMM Judgment

MEMM indicates that the aesthetic judgment of a product is a judgment not just of the product itself, but of the relationship between the product and the effect that it has.²³ If a certain effect is desired in the world, then a product can be designed as the means by which that effect is realized. Designers exploit various resources to achieve the effects they want. The light switch we have taken as an example exhibits a particular sensory property (showing a disrupted pattern when the light is on), exploits a particular working principle (stimulating the inherent human need for order), and elicits a particular interaction from people (making them turn off the light intuitively) to ultimately encourage the conservation of energy (the final effect that we are considering). All these resources (the property, the principle, and the interaction) describe the product as a means.

A product can be perceived to be a minimal means in different senses. In the sense of “few” (or even as “one”), it can be perceived to be minimal if it has few distinct sensory properties

- 16 Dorothy Walsh, "Occam's Razor," *American Philosophical Quarterly* 16, no. 3 (1979): 1–4. This type of elegance also characterizes scientific theories, as noted by David Orrell in *Truth or Beauty: Science and the Quest for Order* (New Haven: Yale University Press, 2012).
- 17 Stuart Margulies, "Principles of Beauty," *Psychological Reports* 41 (1977): 3–11.
- 18 Louis Sullivan, *Kindergarten Chats and Other Writings* (1918; repr. New York: Dover, 1979), 202–13.
- 19 David Best, "The Aesthetic in Sport," *British Journal of Aesthetics* 14, no. 3 (1974): 197–213.
- 20 Robert P. Crease, *The Prism and the Pendulum: The Ten Most Beautiful Experiments in Science* (New York: Random House, 2004), 3–14. A certain economy, a "straightforward elegance," also describes scientific experiments according to George Johnson in *The Ten Most Beautiful Experiments* (New York: Vintage Books, 2009), xi.
- 21 G. H. Hardy, *A Mathematician's Apology* (1940; repr. Cambridge: Cambridge University Press, 1967), 91–94.
- 22 About mathematical demonstrations, see Hardy, *A Mathematician's Apology*, 112–15. About buildings, see Parsons and Carlson, *Functional Beauty* 99, 115. Parsons and Carlson suggest that architecture can be appreciated for both qualities, but they are critical about inevitability. The appraisal of inevitability in architecture can be illustrated with Goethe's description of the Strasbourg Cathedral. For Goethe, this architectural work displays "the beauty of necessity in every smallest part"; "all [its] elements are connected by a rational, if imperceptible, structural necessity." See Susan Bernstein, "Goethe's Architectonic *Bildung* and Buildings in Classical Weimar," *Modern Language Notes* 114, no. 5 (1999): 1023. Meanwhile, the appraisal of unexpectedness in dance can be illustrated with a spectator's admiration of the ballet leap in which "the dancer manages to attain the perceptual effect of stillness by the improbable means of motion." See Boselie and Leeuwenberg, "Birkhoff Revisited," 6–7. For Poe, unexpectedness is a defining quality of the perfect rhyme. See Edgar Allan Poe, "Marginalia," *Graham's Magazine* 28,

(e.g., colors), if it functions on the basis of a single principle or a mechanism comprising a few parts, or if it elicits an interaction requiring just one action or a few steps. In these cases, "minimal" stands for uncomplicated or simple. In the sense of "small," a product can be perceived to be minimal if its properties (e.g., materials) indicate a small investment of resources in its making, if its functioning requires a small investment of resources (e.g., electricity), or if it elicits an interaction requiring little mental or physical effort from people. In these cases, "minimal" stands for inexpensive or undemanding.

The perception of just one salient aspect of a product as being minimal can suffice for the product to be judged minimal overall. For example, we interpret the light switch to be minimal fundamentally because it stimulates people's innate need for order and therefore makes them turn off the light intuitively, without requiring conscious mental effort. The drinking cups manage to stimulate human interaction without redundancy—without adding anything extra to a social occasion, which usually requires some sort of cup for drinking anyway. With only its simple "tattooed" face, the wall clock bridges the gap between two seemingly distant groups of people. The water bottle makes cleaning it, refilling it, and drinking from it easy, partly because it has only a few components that are simply shaped.

To explain how an effect can be perceived to be maximal, we must recognize that products can have more local "proximal effects" and more global "distal effects" (where the distal effects might result from the proximal ones).²⁴ The proximal effect of a product is closely related to the way the product is categorized as belonging to a certain kind. For example, people generally assume that turning a light on and off is a standard attribute of products belonging to the kind "light switch." The more distal effect of a product satisfies a less immediate goal, which is not so closely related to the way the product is typically categorized. In contrast to ordinary light switches, the switch we use as an example has an effect beyond operating the light—it encourages energy conservation. Also, a product can have several effects at any of the levels at which it is influential (however proximal or distal those effects might be). For instance, the water bottle has two effects that are more distal than simply transporting water and that might be considered at a similar level: reducing plastic waste and promoting tap water drinking. In short, products might have different levels of effect and different effects at any level.²⁵ Recognizing this multiplicity helps to explain what can be perceived as a maximal effect.

An effect can be perceived to be maximal in different senses. In the sense of "many," a product can be perceived to have a maximal effect if it has more than one effect at a similar level.²⁶

E_{max}



M_{min}

Figure 5

MEMM allows us to interpret the aesthetic appreciation of a product as an appreciation of a particular means-effect relationship, where the means (product) is minimal (M_{min}) and the (product's) effect is maximal (E_{max}) in relation to each other.

no. 2 (1846): 116–18. About scientific inevitability, see Crease, *The Prism and the Pendulum*, xiv–xxiii; Johnson, *The Ten Most Beautiful Experiments*, xi–xii; and Orrell, *Truth or Beauty*, 136. About musical inevitability, see John Tasker Howard, “Inevitability as a Criterion of Art,” *The Musical Quarterly* 9, no. 3 (1923): 303–13.

- 23 The (intended) effects of products have been categorized by Steven Fokkinga, Paul Hekkert, Pieter Desmet, and Elif Özcan in “From Product to Effect: Towards a Human-Centered Model of Product Impact,” in *Design’s Big Debates: Proceedings of DRS 2014*, ed. Kristina Niedderer and Youn-kyung Lim (Umeå: Umeå Institute of Design, 2014), 71–83. Nathan Crilly, James Moultrie, and P. John Clarkson have also provided a categorization in “Shaping Things: Intended Consumer Response and the Other Determinants of Product Form,” *Design Studies* 30, no. 3 (2009): 224–54.
- 24 This distinction is based on Nathan Crilly, “Function Propagation Through Nested Systems,” *Design Studies* 34, no. 2

The wall clock, like the water bottle, can be perceived to have a maximal effect because it has at least two distal effects: stimulating creativity among prison inmates, and stimulating time appreciation among those who are free from incarceration. In the sense of “big,” a product can be perceived to have a maximal effect simply because it has a distal effect in addition to a proximal one. Just as the light switch does not only operate the light, so the drinking cups do not only contain drinks; they also trigger human interaction and can for that reason be perceived to have a maximal effect.

Although we have described means and effects separately, they are necessarily defined in relation to one another. A particular means is tacitly the means to achieve certain effect, and a particular effect is tacitly the effect achieved by certain means. Furthermore, within any seemingly simple means–effect relationship lies a chain of means and effects. Consider again the light switch, which allows us to establish a means–effect relationship between “showing a disrupted visual pattern when the light is on” (X), and “encouraging energy conservation” (Z). Note that “stimulating people’s innate need for order” (Y) can be inserted between X and Z. This insertion yields the chain X–Y–Z, in which X is a means to Y, Y is an effect of X and a means to Z, and Z is an effect of Y. Following this line of reasoning, intervening means or effects might be identified for any means–effect pair, resulting in an increasingly long chain of means and effects. MEMM, however, does not describe people’s aesthetic judgment in terms of such a chain. Instead, it focuses on any two of the chain’s elements that are identified (in relation to each other) as *the* means and *the* effect (e.g., X and Z, X and Y, or Y and Z). For this reason, we treat our examples in a rather simplified manner, focusing on a particular means–effect pair for analysis while acknowledging that, for any given product, other means–effect pairs also can be identified.

What constitutes minimal and maximal is assessed by establishing a number of relationships, the most obvious of which is the one between a particular means and a particular effect. A given means can be judged to be minimal in relation to a certain effect, and a given effect can be judged to be maximal in relation to a certain means. MEMM allows us to interpret the aesthetic appreciation of a product in this relational sense—that is, as an appreciation of a particular means–effect relationship where the means (product) is minimal and the (product’s) effect is maximal (see Figure 5). The products we use as examples can be judged minimal in relation to their effects, while these effects can be judged maximal in relation to the products. For instance, the drinking cups can be judged minimal in relation to triggering human interaction, while triggering human interaction can be judged maximal in relation to the cups. The wall clock can be judged minimal in relation to both stimulating creativity among

- (2013): 216–42; and on Nathan Crilly, “The Proliferation of Functions: Multiple Systems Playing Multiple Roles in Multiple Supersystems,” in *Artificial Intelligence for Engineering Design, Analysis and Manufacturing* 29, no. 1 (2015): 83–92.
- 25 A similar idea underlies the analysis of artifact aesthetics presented by Rafael De Clercq in “The Aesthetic Peculiarity of Multifunctional Artefacts,” *The British Journal of Aesthetics* 45, no. 4 (2005): 412–25.
- 26 Although the expression “maximal effect” grammatically indicates a singular effect, in this paper we sometimes use it to refer to a set of effects that a product has at a similar level.
- 27 The categorization of artifacts according to designers’ intentions has been discussed by Eric Margolis, Stephen Laurence, and H. Clark Barrett in “Artifacts and Original Intent: a Cross-Cultural Perspective on the Design Stance,” *Journal of Cognition and Culture* 8, no. 1 (2008): 1–22. The kind-based categorization has been examined by Paul Bloom in “Intention, History, and Artifact Concepts,” *Cognition* 60, no. 1 (1996): 1–29. The function-based categorization has been studied by Adele Matan and Susan Carey in “Developmental Changes Within the Core of Artifact Concepts,” *Cognition* 78, no. 1 (2001): 1–26.
- 28 See George Lakoff, *Women, Fire, and Dangerous Things: What Categories Reveal About the Mind* (Chicago: University of Chicago Press, 1990), 5–11.
- 29 Examining how products are judged in terms of alternatives that are based on different categorizations has already led to a better understanding of consumer choice. See E. Marla Felcher, Prashant Malaviya, and Ann L. McGill, “The Role of Taxonomic and Goal-Derived Product Categorization in, Within, and Across Category Judgments,” *Psychology & Marketing* 18, no. 8 (2001): 865–87. We believe that this examination can also lead to a better understanding of aesthetic preference.

prisoners and stimulating time appreciation among those who are free, while these effects can collectively be judged maximal in relation to the clock. Yet MEMM suggests that people’s aesthetic judgment involves an assessment of magnitudes more complex than this.

The Complexity of the MEMM Judgment

We have been using the adjectives “minimal” and “maximal” rather than the superlatives suggested by the conventional statement of MEMM: “minimum” (the least) and “maximum” (the most). Grammatically, superlatives express the greatest possible degree of a quality, which is determined by a comparison. For example, if a room has the greatest amount of light in comparison to another (or several others), then it is *the* lightest. By invoking superlatives, MEMM suggests that the apparently simple judgment of a specific means–effect relationship involves making comparisons with some alternatives in relation to which that particular means and that particular effect can be judged to be *the* minimum and *the* maximum. These alternatives seem to be derived from people’s categorizations of artifacts.

People are naturally inclined to make artifact categorizations based on the intentions that designers have to make things that realize certain effects²⁷—whether these effects are proximal (e.g., turning a light on and off) or distal (e.g., encouraging energy conservation). Categories are not stable; they develop with experience and imagination.²⁸ As people gain knowledge of artifacts and enrich their mental repertoire of artifact possibilities, their categories change, and so “things that turn the light on and off” can eventually include some “things that encourage energy conservation,” and vice versa. Although unstable, these categories provide the grounds to aesthetically judge products in relation to their effects.²⁹

Based on its proximal effect, our light switch can be compared to all known or imagined light switches (starting with those that simply turn the light on and off) and thus can be found to have the maximum effect. Based on its distal effect, it can be compared to all known or imagined things promoting the conservation of energy (including a media awareness program) and so can be found to be the minimum means to achieve such an effect. A means and an effect can thus be judged to be the minimum and the maximum in relation to a set of alternatives that people consider based on their knowledge of existing and possible artifacts.

A given means can be judged to be the minimum relative to other known or imagined means by which the same (or a similar) effect can be achieved. We mentioned that the light switch can be judged to be the minimum means to encourage

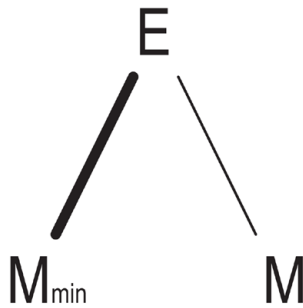


Figure 6

For a given effect, if a number of means (here we only represent two) are assumed as alternatives, the relationship between that effect and what is judged to be the minimum means (M_{\min}) will be aesthetically preferred.

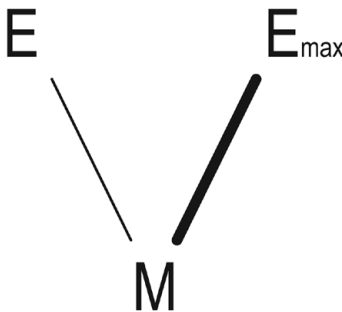


Figure 7

For a given means, if a number of effects (here we only represent two) are assumed as alternatives, the relationship between that means and what is judged to be the maximum effect (E_{\max}) will be aesthetically preferred.

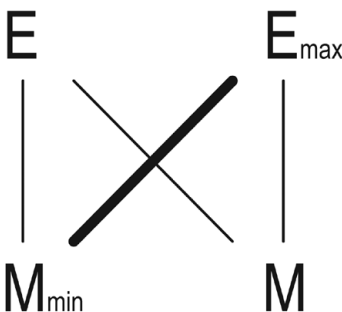


Figure 8

The judgment of any given means-effect relationship is grounded in a set of alternatives assumed for both the means and the effect. Among all possible means-effect relationships established within this set, the one that is judged to be minimum-maximum will be aesthetically preferred.

energy conservation in comparison to a media awareness program. Analogously, the drinking cups can be judged to be the minimum means to trigger human interaction in comparison to a social networking website. The wall clock can be judged to be the minimum means to stimulate creativity among prisoners and appreciation of time among those who are free, in comparison to a handicrafts workshop where these groups of people get to interact meaningfully. The water bottle can be judged to be the minimum means to reduce plastic waste and promote tap water drinking, in comparison to a government's health policy. MEMM allows us to make the following prediction: For a given effect, if a number of means are assumed as alternatives, the relationship between that effect and what is judged to be the minimum means will be aesthetically preferred (see Figure 6).

A given effect can be judged to be the maximum relative to other known or imagined effects that can be achieved through a means of the same (or a similar) kind. Encouraging energy conservation can be judged to be the maximum effect in comparison to operating the light, which might be the only notable effect of a light switch. Triggering human interaction can be similarly judged in comparison to containing drinks, which could be the only effect of a set of drinking cups. Altogether, stimulating creativity and an appreciation of time can be judged to be the maximum effect in comparison to either of these effects separately considered, as well as in relation to giving the time of day, which could be the only effect of a wall clock. Also, reducing plastic waste and promoting tap water drinking can be judged to be the maximum effect in comparison to either of these effects individually considered, as well as in relation to transporting water, which could be the only effect of a water bottle. MEMM allows us to make yet another prediction: For a given means, if a number of effects are assumed as alternatives, the relationship between that means and what is judged to be the maximum effect will be aesthetically preferred (see Figure 7).

MEMM ultimately suggests that the judgment of any given means-effect relationship is grounded in a set of alternatives assumed for both the means and the effect. Among all possible means-effect relationships established within this set, the one that is judged to be minimum-maximum will be aesthetically preferred (see Figure 8). The principle thus implies that people's aesthetic preference for a product emerges from a rather complex process, which involves not only relating the product to its effect, but also comparing means and effects that are assumed as alternatives based on artifact categorizations. We mentioned that these categorizations are developed through experience and imagination. As people gain knowledge of more and more artifacts, they become better able to recall or imagine a richer variety of alternative means and effects with which any given means and effect can be compared.



Figure 9 *Tio* (2009).
Designed by Tim Holley. Photo by
the designer.

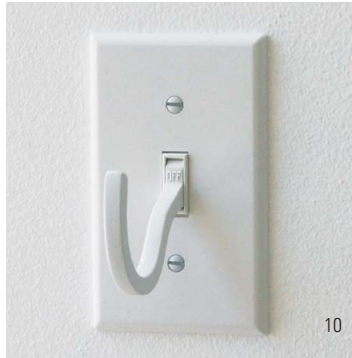


Figure 10 *Hang Off* (2007).
Designed by Scott Amron. Photo by
the designer.



Figure 11 *Switch Me* (2010).
Designed by Josselin Zaïgouche. Photo by
the designer.

We related our light switch to an ordinary light switch (because of its proximal effect) and a media awareness program (because of its distal effect). In both cases, we offered arguments explaining why our switch would be aesthetically preferred. But a set of assumed alternatives could grow to include a switch that not only promotes energy conservation, but also teaches children about the importance of such conservation—for instance, a switch shaped like a ghost that reflects and affects human emotions by going from happy to angry as the light is kept on over time, and vice versa when the light is turned off (see Figure 9). Compared with this switch, which seems to have two distal effects rather than just one, our example could be perceived to have the minimum effect and therefore no longer be preferred.

Predicting aesthetic preference is more difficult when comparing our example with other light switches that seem to have no other distal effect than to promote energy conservation—for instance, a switch that turns off the light automatically when people leave the room, one that persuades people to turn off the light by serving as a useful clothes hanger only when the switch is in the off position (see Figure 10), or one that threatens to release a mouse trap on the finger of whoever dares to turn on the light (see Figure 11). The preference for any of these means to promote energy conservation might be explained by determinants of aesthetic appreciation other than MEMM. For example, preference based on unexpectedness or inevitability would depend on the perception of a particular switch as the unanticipated or seemingly only possible way of promoting the conservation of energy. What is clear is that, as the set of alternative means and effects becomes richer, the aesthetic judgment of a particular artifact also becomes more sophisticated.

Discussion

We have explored the aesthetic judgment of a product as a judgment that involves thinking about the product's effect or purpose. In search of the principles governing people's evaluation of the way a product achieves an effect, we identified MEMM. This principle describes the beauty of a wide range of artifacts,

which suggests that it has a universal capacity to explain the aesthetic appeal of the way something is done. It explains the aesthetic judgment of an artifact as the judgment of a means–effect relationship—a relationship that can be aesthetically appreciated for being efficient (i.e., minimum–maximum), but also for being unexpected or inevitable, among other possible qualities. Hence, MEMM not only accounts for the aesthetic appeal of different artifacts, but also provides the grounds for identifying the different factors that explain such appeal.

We have shown how the means–effect relationship can be established between a product and its effect or purpose, and how the product and the effect can be perceived to be (the) minimum and (the) maximum. We have also indicated that the appreciation of the minimum–maximum relationship between a given means and a given effect depends on a set of assumed alternatives for both the means and the effect. On these grounds, we argue that research in design aesthetics should attend to how people evaluate products based on these sets of known or imagined alternatives.³⁰ We still have much to learn about how people build and use such sets of alternatives, what categorization processes lead them to develop these sets, and to what extent they are aware of making judgments on this basis. Although such questions might well be addressed by a number of different disciplines (including those that employ experimental or scientific methods), the arguments made in this paper suggest some directions for research in the field of design.

The main goal for future theoretical work seems to be to generate a more precise definition of means and effects in design. We have discussed that a product plays the role of a means insofar as it exploits certain resources to achieve an effect. The resources we highlighted (i.e., sensory properties, working principles, and interactions with people) should be further examined, and other resources could be identified. Our categorization of the effects of products was simply based on the distinction between proximal and distal effects. Future research should further categorize the effects of products. For instance, effects could be classified into experiential (e.g., offering a creative experience to prison inmates), attitudinal (e.g., triggering a collaborative attitude among users of a set of cups), and behavioral (e.g., changing people’s behavior in such a way that they conserve energy or reduce plastic waste).³¹ A more precise characterization of means and effects in design would provide a basis for studying the qualities that are aesthetically appreciated in them.

We have argued that means and effects can be appreciated for their perceived magnitudes. To better understand what makes a means (the) minimum and an effect (the) maximum in the design context, future research should conceptually relate the defining

30 We thus agree with Mads Nygaard Folkmann that research into design aesthetics should attend to the role of possibility (because many possible means can be assumed for an effect, and vice versa), and imagination (because some of these possibilities are only imagined, rather than known by experience). See Mads Nygaard Folkmann, *The Aesthetics of Imagination in Design* (Cambridge: Massachusetts Institute of Technology Press, 2013), 1–11.

31 This taxonomy is based on the one offered by Fokkinga et al. in “From Product to Effect,” 71–83.

characteristics of means and effects to such magnitudes. For instance, we might argue that people's effortless interaction with a product plays the most important role in their judgment of the product as the minimum means; or that a behavioral effect can generally be considered to have a greater magnitude than an experiential or attitudinal one because people's behavior has a tangible impact on society.

Since the relationship between means and effects can also be aesthetically characterized by unexpectedness and inevitability, these are qualities worth examining. Based on further review of literature, future research could conceptually define these seemingly incompatible factors and explain how they can jointly contribute to people's appreciation of products.³² Furthermore, theory could be developed on the possible relationships between these qualities and other determinants of aesthetic appreciation, starting with MEMM.

In addition to theoretical research in the directions mentioned, we suggest conducting complementary experimental studies.³³ For example, a study using pairs of products (means) and products' effects as stimulus materials could test aesthetic preference as described in this paper. The experimental design could consist of the dependent variable "aesthetic appreciation," and the independent variables "MEMM," "unexpectedness," and "inevitability." Such a study not only could provide evidence of people's aesthetic appreciation of these qualities in design, but also could reveal if MEMM is a particularly important predictor of such appreciation. The findings would, in turn, suggest new directions for other empirical studies.

To conclude, we want to emphasize how seemingly simple perceptions of product beauty might actually be quite complex. They might involve thinking not only about the product's purpose or effect, but also about a number of alternative products and related effects. A person's assertion that a wall clock or a light switch is beautiful might therefore result from a tacit belief that "another clock would just give me the time of day" or "an awareness program could not make me save energy without my noticing." As researchers in design aesthetics, we must acknowledge and examine such trains of thought. By doing so, we will gain a deeper understanding of the ways in which people experience an increasingly designed world—a world that they increasingly know has been designed for a purpose.

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32 The relationship between unexpectedness and inevitability has already been studied in the field of mathematics. See Alan J. Cain, "Deus Ex Machina and the Aesthetics of Proof," *The Mathematical Intelligencer* 32, no. 3 (2010): 7–11.

33 As a reference, see the studies presented and cited by Odette da Silva, Nathan Crilly, and Paul Hekkert in "How People's Appreciation of Products Is Affected by Their Knowledge of the Designers' Intentions," *International Journal of Design* 9, no. 2 (2015): 21–33.